QA03

Effect of iron-doping on the magnetic properties of $LuMnO_3$

Tai-Chun Han[1] and Jauyn Grace Lin*[2]

[1]Department of Applied Physics, National University of Kaohsiung, Kaohsiung, 811, Taiwan, R. O. C.
[2]Center for Condensed Matter Sciences and Center for Nanostorage Research, National Taiwan University, Taipei, 106, Taiwan, R. O. C.

*Corresponding author: jglin@ntu.edu.tw, Phone: +886-2-33665279, Fax: +886-2-23655404

Hexagonal $RMnO_3$ (R =rare earth element or Y) compounds present opportunities for the industrious applications due to their unique nature of ferroism [1]. Namely, the ferromagnetism, ferroelectricity and ferroelasticity occur simultaneously in same material [2]. In this study, we prepare a series of $LuFe_xMn_{1-x}O_3$ (0 x 0.5) samples by solid state reaction method to study the effect of Fe-doping on their magnetic properties. The x-ray analysis has showed that the structures of these compounds change with the increase of Fe-content from the hexagonal (space group: P63cm) to the orthorhombic perovskite (space group: Pbnm). Based on the data of temperature-dependent magnetization M(T), the antiferromagnetic transition temperature (T_N) shifts to higher temperatures with increasing the Fe-content, as shown in figure 1. It is also found that the values of effective magnetic momentum (μ_{eff}) increase as the iron content increases. According to the result of M-H curve at 10 K, we found that with increasing the Fe-content from 0 to 0.2, the magnetic moment increase continuously from 0.009 to 0.017 μB/f.u. In case of a strong coupling between magnetic moment and electric polarization, the Fe-doped sample may have a higher polarization/ferroelectric effect than that of pure LuMnO3 sample, which should be a great advantage for its future applications.

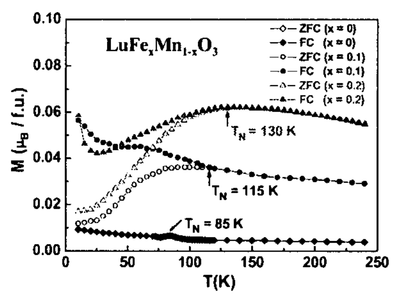

Fig. 1. Zero field-cool (ZFC) and field-cool (FC) magnetization vs. temperature for the LuFexMn1-xO3compounds of x = 0 to 0.2.

*The authors acknowledge the financial support from the National Science Council of R. O. C. under Grant No. NSC95-2120-M-002-002 and 95-2752-M-002-006-PAE.

REFERENCES

[1] M. Fiebig, Th. Lottermoser, Th. Lonkai, A. V. Goltsev and R. V. Pisarev, J. Magn. Magn. Mater., 290-291, 883 (2005).
[2] N. Hur, S. Park, P. A. Sharma, J. S. ahn, S. Guha, and S. W. Cheong, Nature (London), 429, 392 (2004).

QA04

Influence of Sublayer Thickness on Structural and Magnetic Properties of $BaTiO_3/CoFe_2O_4$ Multi-layer Thin Films

Ruei-jer Lin, Lung-jie Hung and Tai-bor Wu*

[1]Department of Materials Science and Engineering, National Tsing Hua University, 101, SEC.2, KuangFu Road, Hsinchu 30043, Taiwan

*Corresponding author: tbwu@mx.nthu.edu.tw, Phone: +886 3 5715131 33852, Fax: +886 3 5751979

Multiferroics, which show ferroelectric (FE) and ferromagnetic (FM) property simultaneously, are of interests for wide applications on high-frequency devices, data storage and transducers. Single phase materials with both ferroelectricity and ferromagnetism at room temperature, however, are rare. Therefore, mixing FE materials with FM ones into composite is an effective and simple method to achieve multiferroic.[1] While for FM materials utilized into composite, the magnetic property was significantly affected by strain and shape effect.[2] By controlling the ferromagnetism of the multiferroic films, the magnetoelectric (ME) coupling mechanism have been investigated.[3]

Amongcomposite systems, multilayer (2-2 type) thick films generated strong ME coupling due to the lower electrical leakage.[4]However, for thin films on a substrate, the ME coupling would be reduced because of the clamping effect by substrate. In this work, multi-layer thin films composed of lead-free FE material $BaTiO_3$ (BTO, lattice constant~0.399nm) and FM material CoFe2O4(CFO, lattice constant~0.839nm) were deposited at a fixed total thickness (160nm) with different stacking periods. Because of the possible coherent growth of BTO/CFO system under a large lattice mismatch (5%),[5]the contribution of each sublayer in nanoscale to the magnetic property was studied.

The BTO and CFO sublayerswere sputtered on BOE etched (100) Si substrate from stoichiometric commercial targets (Toshima, Japan). Dual-cathode RF sputtering system equipped with programmable shutter was used to precisely control the sublayer thickness. We fabricated CFO(40nm)/BTO(120nm), [CFO(20nm)/BTO(60nm)]2 and [CFO(10 nm)/BTO(30 nm)]4 multi-layer thin films (denoted (1×1), (2×2) and (4×4) hereafter). During deposition, substrate temperature and the working pressure were kept at 750°C and 15mtorr with pure Ar.rf power for BTO and CFO deposition were 50w and 90w. The crystalline structure and phase of the films were examined by XRD with Cu Kα radiation. The M-H curves at room temperature were measured by VSM.

The CFO/BTO(1×1) film displayed randomly-oriented polycrystalline structure, and meanwhile with increasing the stacking periods, the (111) orientation of both BTO and CFO was enhanced, but the magnetization was reduced. We ascribed the reduced magnetization to the stress induced by BTO sublayers.

REFERENCES

[1] J. Van den Boomgaard, A. M. J. G. van Run, and J. van Suchtelen, Ferroelectrics 14, 727 (1976).
[2] N. Wakiya, K. Shinozaki and N. Mizutani, Appl. Phys. Lett. 85,16 (2004).
[3] G. Srinivasan, E. T. Rasmussen and R. Hayes, Phys. Rev. B. 67, 014418 (2003)
[4] G. Srinivasan, E. T. Rasmussen, B. J. Levin and R. Hayes, Phys. Rev. B 65, 134402 (2002)
[5] H. Zheng, J. Wang, S. E. Lofland, Z. Ma, L. Mohaddes-Ardabili, T. Zhao, L. Salamanca-Riba, S. R. Shinde, S. B. Ogale, F. Bai, D. Viehland, Y. Jia, D. G. Schlom, M. Wuttig, A. Roytburd, and R. Ramesh, Science 303, 661 (2004).